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Energy Technology Futures
Focus Group
Tuesday, December 15, 1998, Calgary Alberta

"The Role of Hydrocarbons in a Sustainable Energy System"

Introduction:

The Energy Technology Futures (ETF) Group organized its first Focus Group on "the Role of Hydrocarbons in a Sustainable Energy System" on December 15, 1998. The Focus Group was held at the Alberta Department of Energy in Calgary. The primary purpose of the day was to develop views outlining the state of the Canadian hydrocarbon industry in 2050 and the types of technologies, including CO_2 capture and disposal, that could enable the industry to mitigate greenhouse gas emissions.

This was the first focus group on the role of hydrocarbons. Unlike the other areas of focus (e.g. electricity, mobility, and process heat) a Technology Perspective was not prepared on the hydrocarbon industry prior to this session. The following summary is based on the participants' vast knowledge and the ideas developed collectively around the table on December 15. The ETF Group acknowledges that the scenarios developed at the focus group are a first step and additional work will be required. Any comments on the attached information would be most welcome and can be e-mailed to lpatrick@nrcan.gc.ca .

Focus Group Participants:

The Focus Group had fifteen attendees. These included contributors from industry, government (federal and provincial), and academia. The list of attendees is as follows:

1. **Allan Amey**, Technologies and Assessment, TransCanada Pipelines
2. **Roger Bailey**, Director, Research and Technology Branch, Alberta Department of Energy
3. **Graham Boje,** Shell Canada
4. **Amit Chakma**, Dean, Faculty of Engineering, University of Regina
5. **Daphne Cheel**, Science Advisor, Alberta Science and Research Authority
6. **Pietro Di Zanno**, Marketing Manager, Chemical and Refining Industries, Air Liquide
7. **William D. Gunter**, Environmental Technologies, Alberta Research Council
8. **Linton Kulac**, Director, Health, Safety and Environment, Shell Canada Limited
9. **Malcolm McDonald**, Head of Research and Development, TransAlta
10. **John Oxenford**, Responsible for R& D Strategy, Syncrude
11. **Mike Singleton**, Process Development Oil Sands Sustainable Growth, Suncor Energy
12. **Bruce Stewart,** Director, CANMET Western Research Centre, NRCan
13. **Malcolm Wilson**, Resources Policy and Economics Division, Saskatchewan Energy and Mines
14. **Dr. C.S. Wong**, Climate Chemistry Laboratory, Fisheries and Oceans Canada
15. **Paul W. Young**, Environmental Programs, Petro-Canada

Focus Group Presentations:

The session started at 8:30AM with a presentation of the Energy Technology Futures Project and an overview of the objectives of the day. The charge to the group was to develop long term scenarios (2050) for a sustainable energy system. Each participant was asked to envision:

1. What the hydrocarbon economy could look like in 2050?
2. What technologies including CO_2 capture and disposal would be required to make the hydrocarbon industry greenhouse gas (GHG) neutral?
3. How and over what time frame will these technologies evolve?

In order to stimulate and challenge our creative thinking the scenario development was preceded by two presentations: (1) Roger Bailey, Executive Director, Energy Research and Development, Alberta Department of Energy, outlined his predictions on the future (2030 - 2050) of the hydrocarbon industry in Alberta; and, (2) Amit Chakma, Dean, Faculty of Engineering, University of Regina, provided a global vision of the energy economy in 2030 and beyond. Despite the differences in scope, both presentations concluded that hydrocarbons would continue to play a significant role in our future energy systems. Of particular interest was the foreseen continued reliance on coal given its abundant and cheap supply. Therefore, if Nations are seriously going to address climate change, hydrocarbons need be used in a sustainable manner. Technology breakthroughs will be required to mitigate and sequester increasing quantities of greenhouse gases. Furthermore, in many developing nations the climate change issue will need to be linked to increasing pollution and health concerns. *(See appendix B for each presentation.)*

Round Table Discussion:

Following the presentations, each participant was asked to envision the future role of hydrocarbons in a sustainable energy system and provide their own insights with respect to the future and key energy technologies. Based on their input, the following vision emerged:

The Context and the Story

In leading to a future where we can see a sustainable hydrocarbon system, there are several contextual elements that need to be presented.

Society, science, technology, markets, culture and other factors all contribute to climate change and our ability to adapt to it. In order to make significant inroads to the climate change problem, all of these factors will have to come into play and change over the longer term.

From a societal perspective, the human race is very adaptable. However, at this point in time, there is little public awareness of climate change, and no major economic or financial driver for Canadians to respond to the challenge it represents. Probably the greatest driver for GHG issues will be the loss of ecosystems. That is, the closer linkage between climate change and pollution affects (loss of the ability to breathe) will, over the long run, prove to be the major force in making the shift to better GHG management.

From a scientific perspective, there will be growing pressure on the scientific community to demonstrate knowledge of GHG cycles and the impacts that increased concentrations of CO_2 in the atmosphere will have on the Canadian landscape and fabric.

From a technology perspective, there will be a greater need to organize and exchange information on best practices. While there is a view that the technologies necessary to address the CO_2 issue are here now, we do not have the essential circumstances for these technologies to be introduced and for the deployment of newer technologies for better GHG management.

Markets will need to respond to the climate change issue by the broader adaptation of international technologies to Canadian needs, and by reducing the time frame for development of technologies. With the acceptance that climate change is an international problem, there will need to be greater recognition of the role of developing economies, particularly China an India, and the opportunities that these economies offer for expanding the markets for Canadian technologies.

Hydrocarbon Conditions in 2050

By the year 2050, the state of the industry will be very similar to that of today. Canada will:

§ continue to be a world producer of hydrocarbons,
§ energy consumption patterns will not likely change dramatically, and
§ Canadians will continue to demand and use our existing "liquid fuels" infrastructure.

Sources of supply of Canadian hydrocarbons will become more remote, and somewhat more energy intensive. Oil from conventional wells currently non-producible will become viable given the growing use of CO_2 injection (the value of CO_2 disposal in wells will make these sources more economic than they are currently). In addition, the energy production and distribution systems will be collapsed and merged for greater efficiency.

The significant investment in fuel cells will start to pay off in their application in distributed power systems. Coal will continue to play a major role in the energy system particularly in the use of CO_2 storage for the production of coal-bed methane, or through the gasification of coal to liquid fuels (including electrochemical separation).

Natural gas will remain an important source either in direct applications or through the production of syngas. Natural gas, while cleaner than other hydrocarbon fuels, should have a premium, and its use should match this higher value; i.e., natural gas should not be used as a bridging fuel or in point sources (electricity production). In additional non-producing natural gas wells could be used for CO_2 storage over the longer term.

Consumers will still demand the services from energy that are seen today. This service demand focus will allow newer technologies to be more effectively and more widely applied. This can particularly be the case with the application of bio technologies to

produce designer liquid fuels that match the liquid fuel requirements of consumers while meeting the quality demands from, say, the automobile industry for use in their newer designed engines. Similar biotechnology applications such as the insitu anaerobic production of hydrogen for H_2S, or the bioprocessing of oil sands and heavy oils may also be possible.

Sequestration of CO_2

Sequestration of CO_2, especially into fixed energy sources, is the essential ingredient in the development of a sustainable hydrocarbon system. There are large potentials for sequestration in the oil patch, agriculture and forestry sectors. Key to the sequestration issue is the need for better separation technologies (fundamental enabling technologies). In this context as well is the need for membranes for chemical feedstock applications.

Distributed Energy Systems

Growing electrification of the economy will require varied sources of supply, reliance on superconductivity (simple and cost-effective), and energy storage systems possibly Electro-magnetic) to manage supplies on response to loads.

Stand alone systems will be replaced by more distributed ones, and more integrated energy complexes, with on-site production from these "energy plexes" supplying the needs of smaller users. these "plexes" can be cofired systems using coal, biomass, and other fuels, or ceramic fuels cells. These systems will also be using better separation technologies to ensure the capture of CO_2 produced for subsequent storage.

More efficient distribution systems could change the economics and nature of transporting electricity, and could lead to having to make more fundamental infrastructure decisions.

Nuclear fission and fusion could have a huge future, but overhead costs could severely limit the role that this source could have.

Breakout Session – Scenario Building

In the afternoon the participants formed two sub-groups. The purpose of the breakout session was to further develop scenarios with respect to the future of the Canadian energy economy. Group A chose to "beam" itself directly to the year 2050, while Group B elected to take a step by step approach. The following summarizes the vision of each group.

Group A envisioned the Canadian economy consisting of two distinct, but necessary types of society – the Green Society and the Consuming Society. Both of these societies will exist and each is reliant on the other.

The Green Society is a more centralized urban society that relies greatly on advanced communications (e.g. tele-commuting, tele-medicine) and a mass public transportation system. It relies on localized solutions and personal choice is important. Industry tends to be light and distributed.

Key Energy Attributes:

- § relies on a distributed power/heating system;
- § energy storage is important;
- § clean and efficient transportation and storage of energy is important;
- § favours high quality liquid hydrocarbons;
- § alternative and renewable energies capture a greater market share;.
- § technologies that allow for "ultra-efficiencies" are important.
- § Micro-technologies (e.g. micro gas separation technologies, micro-turbines, and micro-powered generation) will be important.

The Consuming Society is characterized by continued urban sprawl. Society continues to value personal mobility, but demands highly efficient vehicles. Society demands the cleanest, cheapest and most reliable energy source. Individuals look to industry and government for centralized solutions. Economic growth is emphasized. Industry tends to be large scale and integrated, with a greater emphasis on energy utilization (i.e. co-generation, networked and by-product synergies).

Key Energy Attributes:

- § Relies on industrial "energy plexes" – taking full advantage of economies of scale;
- § Large centralized energy storage is required;
- § Large scale capture of carbon dioxide at the point of source;
- § Industrial ecology is accelerated;
- § Large scale gas separation technologies;
- § Increased reliance on energy transmission;
- § High density gas storage.